MAGNETIC CODER KEYER

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STATUS REPORT

Project No. 2529

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[redacted]

STATUS REPORT

This report concerns the status of the [redacted] project. Recommendations are made concerning manufacture, and possibilities for further development and size reduction are discussed.

The prototype [redacted] is an almost-pocket-size device which performs the following functions:

1. Storage of messages up to 120 groups in length, in three sections, as typed out on its full keyboard.

2. Transmission at 60 wpm rate non-destructively.

3. Correction of errors while typing, using the backspace.

4. Copying or checking a stored numerical message, using the built-in lamp readout device.

5. Economical operation from flashlight batteries or rechargeable batteries.

Other capabilities already partly installed, but not tested because of early delivery of the prototype are:

1. Transmission at any desired rate up to 1600 wpm. (Parallel and staggered-parallel outputs already exist within the unit in addition to serial baudot.)

2. Reception off-the-air (when used with a receiver) at rates up to 1600 wpm, with consideration of multipath, using the electronic analog of strobed start-stop operation. Message stored in this way is then copied onto paper by the operator, using the readout device.

3. Simple base station use in automatic storage and conversion of incoming high-speed messages, permitting 60 wpm page copy.

4. Various unattended applications.

No phase of the development has thus far indicated that operation with full margins over the environmental range of -40° to +50° cannot be obtained, with the standard shelf-item non-selected components now employed.

Circuit margin calculations have been carried to sufficient detail to firm all major and critical circuits. Many minor margin calculations remain to be made. It has already been determined that a wide latitude exists in which to set the circuit parameters in these cases. This development practice has made possible the speedy completion of the [redacted] as a feasibility model. [redacted] will not be operationally reliable until all marginal parameters have been corrected. The final phase of the development would result in a reliable production prototype, the [redacted] STAT STAT

The [redacted] construction is a wired assembly of printed-circuit modules. Modules are used for these reasons: STAT

1. Some circuitry, duplicated up to seven times, is best modularized.

2. Modules permit individual testing and simultaneous construction during manufacture.

3. An easy transition to plugged, non-wired modules is planned for the production prototype.

4. Substitution repairs may be made (but not in the field).

5. Alterations, often necessary during a rapid development, are easily effected.

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There are additional reasons for the use of modular construction, which involve the feasibility of having the [redacted] manufactured under contract. STAT

The [redacted] contains circuits not yet in industrial use, which were developed from "scratch" during the project. Transistors and cores are employed in bizarre arrangements which perform functions such as sense amplifier, voltage regulator, pulse generator, etc., and the project staff has required two years of constant familiarization with these circuits to work effectively with them. They are definitely in the experimental stage except in these particular configurations, which are now well understood by the staff. Without these circuits, the CK-14 cannot be duplicated in its present size, weight, and cost. A consideration affecting disposition of this project is that it would be impossible to transplant the development of the [redacted] without allowing at least an equal time for a new staff to become familiar with the circuitry to the point of being able to improve or modify it. STAT STAT

It is recommended instead that any manufacturer be presented with a completed design only. Completeness implies that all passive components values be specified, together with such tolerances and temperature coefficients as are necessary to meet the circuit margins at all temperatures and for all samples. (Slip-ups are inevitable, and will require speedy attention of the project staff as they occur. These errors will become apparent only during quantity manufacture. It is very doubtful whether the production contractor could cope with them unassisted.)

The modular construction of the [redacted] permits the establishment of independent electrical specs for each module. This relieves the contractor of a considerable burden, since acceptance could be based on all manufactured modules meeting their detailed specifications, with responsibility resting upon the development staff for correctness of design and operation of the complete assembly. The contractor would be held responsible for use of proper components and quality of construction. Interchangeability of modules is also assured, and the staff, in supervising final assembly, can apprehend design weaknesses or unacceptable quality <u>before</u> they are built into the product. STAT

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Independent module specs offer another attribute still: the possibility of manufacture under multiple contracts. Often, delivery of a contracted equipment is stretched into years because of inexperience or nonchalance on the part of the manufacturer. In industry the principle of multiple suppliers is invariably used where such delays could result in great financial loss. If different modules of the [redacted] were let to different contractors, unfruitful contracts could be terminated without great losses, and the remaining work done under the development staff. The simultaneous production of various portions of the CK-14 would result in direct time savings.

Should quantity production of this magnitude not be desired, or if microminiaturization is essential to effective employment of this device, it is nevertheless considered necessary to carry out some small quantity production in the form of the planned prototype before letting the microminiaturization contract. The circuit design, including margins and tolerances, can thereby be at least partially confirmed, and unforseen problems corrected.

The project staff therefore recommends that, in addition to continued development and construction of one [redacted] final prototype, a production run of approximately ten units with stock components be scheduled.

It is further recommended that the microminiaturization contract itself contain the following procedures:

1. The contractor splits the device into modules as with his standard practice, but corresponding to the present subdivision wherever possible or desirable.

2. The modules as microminiaturized must conform to the same electrical specs as before, naturally, if the circuit is to operate, therefore, acceptance should be based on individual modules meeting their specs. Where module subdivisions have been changed for convenience, new electrical specs can be prepared by the development staff. The contractor is thus unburdened, not restricted.

It is emphasized that it is unrealistic to assume that circuits and component values can be changed in order to permit use of smaller components. The entire development has been based on the use of fewer components, with the result that a great many magnetic cores are employed. Although these items are "small" to begin with, physical laws prevent changes in size unless new metallurgical advances are made. However, there is no question but that use of the microminiature-cased equivalents of the passive and semiconductor components now specified by the design will result in a startling size reduction, even though magnetic cores of the present type are used.

When microminiature equivalents with unchanged values are substituted for the present components, three existent design problems will be greatly enlarged. These are:

1. Temperature and age variations which will cause the unit to become inoperative if they exceed specified amounts. (These are already approached closely.)

2. Reliability: unexpected temperature and age variations, and drastic failures, always encountered with new and limited production components to a far greater degree than shelf-item components of some standing.

3. Cost.

The present [redacted] is almost the last step in a project which has expended ingenuity and effort to a considerable degree in obtaining a balance of these three factors with factors of size, weight, utility, etc. It is felt that all such factors have been brought to levels which are not ideal but are acceptable. Further effort would next be concentrated in retaining the present levels but making the unit easier to build. The staff feels that the unit can be made surprisingly easy to build. Microminiaturization by several approaches may make construction even easier; it is urged that any other microminiaturization approaches be ruled out. STAT

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One aspect which may not be traded off at all is reliability. If the production prototype [redacted] design is indeed correct, the reliability of the device will be no worse than the aggregate reliability of its components. Because of the number of components, this figure is barely acceptable. Should component values or component stability be hedged in microminiaturizing the design, the result will of course be frequent instances where "the equipment won't work but all the components are good." In other words, even the component reliability level will not be reached. For example, the [redacted] contains about 85 transistors. Assume that any one of these can cause failure of the entire unit (not strictly true). If the stock item transistors have a random failure rate of the order of one failure every ten thousand unit hours, then [redacted] can be expected to fail in the same conditions every 112 hours, average. Problems such as this are inescapable. Use of approaches with hundreds of transistors in order to achieve smaller size, or use of less reliable micro transistors in the present approach to achieve smaller size, might result in failure intervals of scores of hours instead of hundreds. The outcome could be small expensive devices that don't work.

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Another approach to a more convenient configuration for the [redacted] using standard components, is division into three or more subunits. The development program has kept this in mind from the start, and possible dividing points do exist. Connector reliability and operator confidence appear to be the only important factors, and are not serious problems. STAT

In conclusion, the courses of action considered most desirable by the [redacted] staff are: STAT

1. Continued prototype development and pilot production (2 or 3 units), followed by large-scale or medium-scale production of the planned design in single-unit or subunit configuration, using stock components, under multiple contracts of several module-types per contractor. Memory fabrication under separate contract. Simultaneous completion of all contracts and assembly by the [redacted] staff. Temperature cycling and necessary margin tests by the staff on all units. STAT

2. Continued prototype development and production of ten units by the staff, with tests as described. Subsequent microminiaturization contract with acceptance of modules before final assembly, based on staff specs. Tests by staff after completion.